

ISOLATED GALAXIES, PAIRS AND GROUPS OF GALAXIES

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We searched for isolated galaxies, pairs and groups of galaxies in the CfA survey (Huchra *et al.* 1983). It was assumed that the distances to galaxies are given by $R = V/H_0$, where $H_0 = 100 \text{ km s}^{-1} \text{ Mpc}^{-1}$ and $R > 6 \text{ Mpc}$.

The searching procedure is close to those, applied to find superclusters of galaxies (Kalinkov and Kuneva 1985, 1986). A sphere with fixed radius r^* is described around each galaxy. The mean spatial density in the sphere is m . Let G^1 be any galaxy and G^2 be its nearest neighbor at a distance R_2 . If R_2 exceeds the 95% quintile in the distribution of the distances of the second neighbors, then G^1 is an isolated galaxy. Let the midpoint of G^1 and G^2 be O_2 and $r_2 = R_2/2$. For the volume V_2 , defined with the radius r_2 , the density $D_2 = 2/V_2$ is calculated. Here 2 stands for the number of galaxies in the volume V_2 . We use inequalities to establish regions with density enhancements higher than $k \mu$. Thus, if $D_2 < k\mu$, the galaxy G^2 is a single one and the procedure for searching for pairs and groups, beginning with this object is over and we have to pass to another object. If $D_2 > k\mu$, the searching procedure goes on. Let then G^3 be the third neighbor of O_2 and let O_3 be the center of G^1 , G^2 and G^3 ; $r_3 = \max(O_3G^1, O_3G^2, O_3G^3)$ is calculated and around O_3 we describe a sphere with radius r_3 of volume V_3 and density $D_3 = 3/V_3$. If $D_3 < k\mu$, it might be concluded that the galaxies G^1 and G^2 form a pair for the specific choice of k and r . The pair is isolated, if the distance O_2G^3 exceeds the 95% quintile in the distribution of the distances of the third neighbors. Then the procedure for the galaxy G^1 ends. For $D_3 > k\mu$, the procedure continues. Generally, the procedure for searching for multiplets continues for $D_i > k\mu$. If $D < k\mu$, the procedure stops with the finding of a multiplet consisting of $i-1$ members ($i = 2, 3, \dots$) and the test for isolation with the 95% quintile in the distribution of the distances to the i -th neighbors.

The algorithm is objective, but it is not always commutative because of the local character of the spatial density. The main difference however between our and some other procedures is the local density. In many cases our groups are closed - it means that the multiplets are independent of the choice of galaxy with which the search has started. But there are some groups which are open - their membership is slightly different, depending on the galaxy with which the procedure has started.

Here the authors present the groups - isolated and nonisolated - with $n > 3$, found in the CfA survey in the Northern galactic hemisphere. The parameters used are $k = 10$ and $r^* = 5 \text{ Mpc}$. Table 1 contains: (1) the group number, (2) the galaxy, nearest to the multiplet center, (3) multiplicity n , (4) the brightest galaxy if it is not listed in (2); (5) and (6) are R.A. and Dec. (1950), (7) - mean distance D in Mpc. Further there are the mean density ρ (8) of the multiplet (galaxies Mpc^{-3}), (9) the density ρ^* for $r^* = 5 \text{ Mpc}$ and (10) the density ρ_g for the group with its nearest neighbor. The parenthesized digits for densities in the last three columns are powers of ten.

TABLE 1

	Center	<i>n</i>	Brightest	α	δ	D	ρ	ρ^*	ρ_g
1	N2769	4	N2693	9 02.0	51 09	48.5	5.8(-1)	1.3(-2)	6.8(-2)
2	U04906	3	N2701	9 05.8	52 53	22.8	6.7(-1)	1.7(-2)	4.0(-2)
3	N2780	3	N2770	9 08.4	34 33	19.7	6.1	2.9(-2)	5.4(-2)
4	N2799	4	N2712	9 11.2	42 29	18.2	4.7(-1)	4.4(-2)	5.4(-2)
5	U04870	3		9 14.4	46 41	42.7	3.2(-1)	9.6(-3)	2.4(-2)
6	N2856	4	N2776	9 17.5	47 12	26.7	4.8(-1)	1.1(-2)	4.6(-2)
7	N2814	4	N2805	9 19.2	64 00	16.4	9.5(-1)	8.8(-2)	9.9(-2)
8	N2914	4	U05189	9 33.5	10 02	31.7	8.2(-1)	1.1(-2)	2.2(-2)
9	N3024	3	N3020	9 49.1	11 51	14.8	2.6	8.6(-2)	3.0(-1)
10	N3011	7	N3003	9 49.3	32 02	14.9	1.7	1.2(-1)	5.6(-1)
11	U05520	3	N2909	10 02.9	65 40	33.1	2.7(-1)	1.3(-2)	4.3(-2)
12	U05459	5	N3079	10 04.9	54 53	11.1	2.9	2.2(-1)	6.0(-1)
13	I 591	3	N3107	10 05.6	13 06	27.5	1.1	2.1(-2)	2.8(-2)
14	N3104	4	N3184	10 09.3	43 56	6.1	4.2	3.7(-1)	7.6(-1)
15	N3169	5	N3166	10 11.1	4 20	13.0	1.5	1.4(-1)	4.9(-1)
16	N3189	10	N3227	10 19.6	22 03	13.0	1.8	1.7(-1)	1.2
17	N3245	5		10 25.5	28 24	13.9	1.9	1.6(-1)	6.5(-1)
18	N3353	3	N3310	10 35.7	55 26	9.6	1.0(+1)	2.9(-1)	3.3(-1)
19	U05760	7	N3367	10 39.0	14 00	29.9	3.4(-1)	2.7(-2)	7.4(-2)
20	N3346	5	N3338	10 42.2	14 38	12.6	2.2	1.8(-1)	6.7(-1)
21	N3381	6	N3294	10 42.4	34 38	15.9	1.4	1.1(-1)	4.1(-1)
22	U05955	3	N3403	10 43.0	73 20	11.9	3.5	1.6(-1)	1.2(-1)
23	N3368	3		10 45.9	12 52	9.0	2.0(+1)	3.5(-1)	6.0(-1)
24	N3433	3		10 50.1	10 22	26.9	5.1(-1)	2.5(-2)	3.7(-2)
25	N3414	3		10 52.6	28 26	14.2	5.7	1.6(-1)	6.0(-1)
26	N3454	5	N3457	10 53.2	18 16	11.3	1.5(+1)	2.9(-1)	1.3
27	N3486	3	N3344	10 53.2	27 52	7.0	6.5	4.6(-1)	1.0
28	U06106	3	U06135	10 59.5	45 55	64.9	3.2(-1)	1.2(-2)	1.8(-2)
29	N3489	5	N3627	10 59.6	13 32	7.1	6.1	4.3(-1)	1.7
30	N3625	9	N3613	11 09.2	57 57	19.7	1.4	5.3(-2)	3.8(-1)
31	U06296	3	N3507	11 09.8	18 16	9.7	1.1(+1)	4.7(-1)	1.6
32	N3549	4		11 10.2	52 41	28.6	2.1(-1)	2.1(-2)	7.4(-2)
33	N3628	3		11 15.6	15 12	8.3	5.4	4.4(-1)	8.5(-1)
34	U06345	3	N3630	11 16.8	3 37	15.8	2.3	7.3(-2)	1.7(-1)
35	N3686	5	N3596	11 20.1	17 05	11.9	7.6	4.1(-1)	1.7
36	N3665	4		11 20.8	39 01	20.8	8.6	3.2(-2)	1.3(-1)
37	N3556	3		11 29.1	55 14	6.8	5.7	3.4(-1)	1.2
38	N3788	4	N3687	11 32.6	31 46	26.2	2.3(-1)	2.1(-2)	6.6(-2)
39	N3755	3	N3813	11 35.3	36 22	15.4	1.3	7.4(-2)	4.8(-2)

TABLE 1 (continued)

	Center	<i>n</i>	Brightest	α	δ	D	ρ	ρ^*	ρ_g
40	N3735	3		11 35.4	70 53	27.4	1.0	3.8(-2)	1.1(-1)
41	N3853	6	N3800	11 38.2	17 13	33.0	3.5	3.2(-2)	1.8(-1)
42	N3770	10	N3963	11 38.7	59 47	32.0	5.1(-1)	3.6(-2)	1.9(-1)
43	N3817	4	N3839	11 39.2	10 36	61.0	2.0(-1)	1.9(-2)	9.4(-2)
44	N3816	3		11 40.6	20 20	55.1	9.2(-1)	1.1(-2)	4.6(-2)
45	U06575	16	N3898	11 41.0	58 57	12.3	2.6	2.2(-1)	1.7
46	N3837	3	N3842	11 41.7	20 10	62.8	3.3(-1)	2.9(-2)	1.5(-1)
47	N3900	3		11 44.0	27 35	18.0	3.7	6.1(-2)	4.5(-2)
48	N3902	6	N3812	11 45.0	25 46	36.7	9.4(-1)	4.0(-2)	2.2(-1)
49	N3929	3	N3883	11 48.1	21 08	70.5	4.6(-1)	2.1(-2)	6.6(-2)
50	N3906	13	N3726	11 48.2	49 45	9.5	1.3(+1)	3.4(-1)	2.6
51	U06923	9	N3992	11 54.2	53 23	10.8	4.4	2.8(-1)	1.9
52	U06925	10	N3995	11 54.3	32 28	31.5	3.3(-1)	3.1(-2)	1.9(-1)
53	N4005	4		11 55.7	25 26	44.2	5.5(-1)	9.6(-3)	4.4(-2)
54	N4004	3	N4017	11 55.7	28 07	34.6	9.2(-1)	5.0(-2)	1.8(-1)
55	N4026	3		11 56.5	52 10	8.7	2.6(+1)	3.4(-1)	3.7
56	N3949	18	N3938	11 59.1	46 49	7.6	6.6	4.6(-1)	2.6
57	N4061	4	N4070	12 02.0	20 41	73.2	1.0	1.0(-3)	1.5(-2)
58	N4128	3		12 03.7	69 30	23.2	7.8(-1)	4.0(-2)	1.7(-1)
59	N4117	6	N4151	12 04.2	41 56	9.8	6.6	3.8(-1)	1.6
60	N4116	3	N4123	12 07.0	2 34	13.0	3.0	2.9(-1)	6.1(-1)
61	N4205	4	N4036	12 09.2	63 59	14.3	1.8	1.8(-1)	8.0(-1)
62	N4189	3		12 09.8	14 08	21.6	1.3	1.2(-1)	2.8(-1)
63	N4185	8	N4169	12 10.1	29 22	38.8	4.7(-1)	2.9(-2)	3.4(-2)
64	N4081	3	N4125	12 10.2	65 08	13.3	5.7	1.7(-1)	1.2
65	N4197	4	N4215	12 12.6	6 01	20.9	2.4	1.4(-1)	6.7(-1)
66	U07395	3	N4229	12 12.9	32 23	67.6	1.2(-1)	1.0(-2)	2.2(-2)
67	N4256	5		12 13.8	66 19	25.4	7.3(-1)	5.5(-2)	2.0(-1)
68	N4200	3	N4168	12 14.5	12 48	23.2	2.2	1.0(-1)	3.3(-1)
69	N4235	8	N4378	12 16.4	6 44	25.9	1.4	7.8(-2)	5.2(-1)
70	I3115	9	N4261	12 16.8	6 09	22.8	1.6	1.2(-1)	6.4(-1)
71	N4254	3		12 16.9	13 42	24.8	1.3	8.6(-2)	2.6(-1)
72	N4251	3	N4314	12 17.8	29 24	10.1	1.1(+1)	5.1(-1)	9.6(-1)
73	N4303	3		12 18.5	4 33	15.8	1.2(+2)	2.1(-1)	7.8(-1)
74	N4290	3		12 18.5	58 24	30.8	6.0(-1)	3.8(-2)	1.0(-1)
75	N4306	3	N4313	12 20.1	12 16	15.1	3.3	2.5(-1)	2.5(-1)
76	N4274	4		12 20.7	30 24	9.0	1.5(+1)	5.5(-1)	2.3
77	N4510	5	N4545	12 22.1	64 56	27.8	8.5(-1)	5.3(-2)	2.7(-1)
78	N4335	4		12 22.4	57 50	46.4	2.4(-1)	1.3(-2)	3.9(-2)

TABLE 1(continued)

	Center	<i>n</i>	Brightest	α	δ	D	ρ	ρ^*	ρ_g
79	N4472	7		12 23.4	8 07	10.2	7.7	4.2(-1)	4.8
80	N4340	14	N4293	12 24.0	15 03	9.4	6.1	5.0(-1)	3.1
81	U07428	3	N4525	12 24.2	31 35	12.1	5.7	3.7(-1)	5.5(-1)
82	N4412	6	N4527	12 24.4	4 08	17.1	4.8	1.6(-1)	8.8(-1)
83	N4414	3		12 24.4	29 25	7.2	1.1(+1)	5.4(-1)	2.8
84	N4461	4		12 24.6	13 02	19.2	4.4	1.6(-1)	5.7(-1)
85	N4308	5	N4631	12 25.0	31 04	6.2	1.9(+1)	5.1(-1)	3.3
86	N4519	12	N4486	12 25.3	9 25	12.4	4.2	3.4(-1)	2.6
87	N4421	6	N4321	12 25.6	15 09	16.1	2.8	2.0(-1)	1.0
88	N4477	6		12 26.0	13 18	13.7	4.0	3.2(-1)	1.6
89	N4458	4	N4206	12 26.6	14 01	6.8	7.6	4.8(-1)	2.5
90	I3521	9	N4526	12 26.7	10 07	5.6	6.8	4.2(-1)	1.3
91	N4350	4		12 26.7	17 16	12.7	4.4	3.7(-1)	1.7
92	N4291	8		12 27.8	74 40	17.0	5.1(-1)	5.0(-2)	3.0(-1)
93	N4435	4	N4382	12 29.2	15 35	7.9	7.6	4.7(-1)	1.4
94	N4501	3		12 29.4	14 41	22.8	1.4	1.1(-1)	4.7(-1)
95	1226+43	14	N5055	12 30.0	44 11	5.3	5.4	4.8(-1)	5.1
96	N4568	4		12 33.6	10 35	22.5	1.9	1.2(-1)	4.1(-1)
97	N4623	3	N4570	12 34.1	7 56	17.7	3.5	1.5(-1)	5.4(-1)
98	N4587	3	N4636	12 34.2	3 15	9.1	1.7(+1)	3.6(-1)	1.2
99	N4596	3		12 34.6	10 39	18.5	2.1	1.7(-1)	9.0(-1)
100	N4564	8	N4649	12 34.9	11 24	11.	1.1(+1)	4.0(-1)	2.8
101	N4598	4	N4535	12 35.1	7 58	19.	2.0	1.6(-1)	5.8(-1)
102	N4600	10	N4665	12 37.2	5 03	7.	5.4	3.7(-1)	2.3
103	I3651	3	N4615	12 38.8	26 33	47.	3.3	9.6(-3)	2.7(-2)
104	N4687	3	U07812	12 42.6	34 32	42.	6.7(-2)	5.7(-3)	5.2(-3)
105	N4725	3		12 43.7	26 02	12.	5.7	3.3(-1)	7.2(-1)
106	N4695	4	N4686	12 45.0	54 39	49.4	9.0(-1)	1.7(-2)	2.7(-2)
107	N4762	3	N4654	12 45.9	11 13	10.2	1.1(+1)	4.0(-1)	2.1
108	N4795	3		12 52.1	8 53	28.0	2.6	2.3(-2)	4.3(-2)
109	N4816	4	N4819	12 54.0	27 57	68.2	2.8(-1)	2.5(-2)	6.8(-2)
110	N4904	3	N4845	12 54.9	1 13	11.8	4.3	2.5(-1)	4.1(-1)
111	N4853	3	N4839	12 55.2	27 42	75.5	5.4(-1)	1.7(-2)	6.9(-2)
112	I4189	5	N4914	13 01.5	36 28	47.4	4.4(-1)	1.2(-2)	1.0(-2)
113	N4966	3	N4944	13 04.7	29 14	69.9	2.6(-1)	1.9(-2)	3.5(-2)
114	N5056	3		13 12.1	30 34	56.0	1.5(-1)	1.2(-2)	2.0(-2)
115	N5112	3		13 15.8	38 22	9.8	6.5	3.3(-1)	7.6(-1)
116	N5218	3		13 22.6	62 51	28.9	8.6(-1)	3.8(-2)	6.4(-2)
117	N5142	3	N5149	13 23.1	36 30	53.6	9.0(-2)	5.7(-3)	5.8(-3)

TABLE 1(continued)

	Center	<i>n</i>	Brightest	α	δ	D	ρ	ρ^*	ρ_g
118	N5208	3	I 900	13 30.8	8 12	68.0	1.5(-1)	1.3(-2)	1.8(-2)
119	U08561	3		13 32.0	34 11	72.9	4.2(-1)	1.2(-2)	3.2(-2)
120	N5221	3	N5230	13 32.7	14 00	69.8	7.6(-1)	1.7(-2)	3.6(-2)
121	N5320	7	N5371	13 47.3	40 54	25.9	1.1	5.7(-2)	3.5(-1)
122	N5379	5	N5322	13 47.5	60 25	17.8	1.0	7.8(-2)	2.0(-1)
123	N5300	3	N5364	13 51.0	4 59	11.9	2.3	2.1(-1)	4.7(-1)
124	I 948	3		13 51.1	14 09	68.8	1.2	9.6(-3)	1.6(-2)
125	N5383	7		13 51.8	41 15	22.6	9.9(-1)	8.0(-2)	4.6(-1)
126	N5341	4	N5395	13 53.6	37 54	35.6	2.8(-1)	2.3(-2)	4.8(-2)
127	U08883	3	U08827	13 54.2	15 30	56.1	5.7(-1)	1.5(-2)	3.2(-2)
128	N5382	3	N5374	13 55.5	6 29	43.0	9.0(+1)	1.5(-2)	4.1(-2)
129	N5416	3		14 00.0	9 42	61.7	2.4(-1)	1.2(-2)	3.2(-2)
130	N5434	3	N5417	14 00.1	8 38	46.6	2.0(-1)	1.5(-2)	1.5(-2)
131	N5445	4	N5444	14 01.2	35 24	38.6	5.5(-1)	2.9(-2)	9.5(-2)
132	U09081	3	N5406	14 02.1	39.28	52.9	1.8(-1)	1.2(-2)	1.6(-2)
133	U09056	7	N5448	14 05.1	49 49	20.0	9.9(-1)	8.8(-2)	7.9(-1)
134	U08980	3	U08975	14 05.7	39 16	58.0	1.2(-1)	1.2(-2)	1.9(-2)
135	U09062	3	N5490	14 08.7	19 01	50.4	1.8(-1)	1.2(-2)	2.3(-2)
136	N5631	8	N5678	14 13.1	56 48	19.7	9.3(-1)	8.0(-2)	4.9(-1)
137	I1000	3		14 20.2	18 07	56.6	2.2(-1)	1.2(-2)	2.2(-2)
138	N5590	5	N5557	14 20.8	36 06	32.5	3.7(-1)	3.2(-2)	1.4(-1)
139	U09356	6	N5665	14 25.4	12 32	22.7	2.7(-1)	1.7(-2)	8.6(-2)
140	N5641	3		14 26.8	28 59	43.5	6.4(-1)	1.3(-2)	5.1(-2)
141	N5649	3		14 27.7	14 10	51.9	1.2	1.2(-2)	4.8(-2)
142	N5653	3		14 27.8	32 16	35.1	1.1	2.7(-2)	6.1(-2)
143	N5669	3		14 28.1	10 32	13.5	8.9(-1)	8.6(-2)	1.1(-1)
144	N5689	7	N5676	14 31.6	49 34	21.8	1.0	8.4(-2)	4.4(-1)
145	N5675	3	N5695	14 33.2	36 41	41.7	5.7(-1)	1.9(-2)	2.8(-2)
146	N5735	3		14 35.1	29 40	37.8	1.8(-1)	1.3(-2)	3.2(-2)
147	N5692	19	N5566	14 36.1	3 35	15.9	1.0	8.0(-2)	6.0(-1)
148	U09519	4	N5798	14 44.0	32 06	17.5	2.7(-1)	2.3(-2)	3.1(-2)
149	N5804	4	N5797	14 55.8	49 58	40.9	9.3(-1)	1.2(-2)	3.3(-1)
150	N5838	3		15 01.3	2 04	13.9	4.8	7.8(-2)	3.3(-1)
151	N5820	6	N5905	15 03.9	54 46	32.3	2.0(-1)	1.9(-2)	5.1(-2)
152	N5906	3	N5866	15 17.3	56 24	6.6	4.1(+1)	2.0(-1)	6.1(-1)
153	N5930	4	N5899	15 21.7	41 40	25.8	1.7	1.3(-2)	4.6(-2)
154	N5985	3		15 28.7	59 41	25.4	4.7-1	1.9(-2)	2.3(-2)
155	I4564	6	I4567	15 32.3	43 27	56.7	1.8(-1)	1.5(-2)	1.7(-2)
156	N5974	3	N5958	15 34.3	30 35	19.5	3.6(-1)	1.5(-2)	3.0(-2)

TABLE 1(continued)

	Center	<i>n</i>	Brightest	α	δ	D	ρ	ρ^*	ρ_g
157	N5956	8	N5962	15 35.5	14 14	419.1	5.2(-1)	2.8(-2)	8.1(-2)
158	N5982	3		15 39.0	59 13	29.3	1.6	1.9(-2)	4.2(-2)
159	I1151	3		15 50.7	18 21	21.5	3.8(-1)	2.3(-2)	6.8(-2)
160	U10127	3	N6052	15 57.3	20 59	48.0	2.1(-1)	1.9(-2)	4.2(-2)
161	I1174	3	N6021	16 02.1	16 02	47.3	3.0(-1)	1.5(-2)	4.0(-2)

There are many coincidences between groups from Table 1 and groups from other catalogs (Turner and Gott 1976, Huchra and Geller 1982, Vennik 1984, Tully 1987). Some groups from the Geller and Huchra (1983) catalog are merged in Table 1 and vice versa, some groups from Table 1 are merged in the GH catalog.

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